

Abiotic reactions may be the most important mechanism  
in natural attenuation of chlorinated solvents

**John T. Wilson**

U.S. EPA/ORD/NRMRL/GWERD

Ada, Ok

Phone: 580-436-8532 Email wilson.johnt@epamail.epa.gov

Co-author:

Mark Ferrey

Minnesota Pollution Control Agency

The EPA *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* was developed with the assumption that natural biological reductive dechlorination was the only important mechanism for destruction of chlorinated solvents and their reduction daughter products in ground water. If cis-dichloroethylene was produced in a plume but there was no evidence of vinyl chloride or ethene and ethane, this was taken as evidence that the biological processes had “stalled”, that natural treatment was incomplete, and that natural attenuation was not indicated as a remedy for chlorinated solvents in the plume.

Recent laboratory studies have shown that chlorinated alkenes can react with a variety of iron minerals that are commonly found in aquifers, to produce acetylene. The rates of abiotic degradation of chlorinated solvents in these laboratory systems are adequate to explain the existing distribution of contaminants in many plumes where trichloroethylene is dechlorinated to cis-dichloroethylene, and the cis-dichloroethylene appears to attenuate as well, but no reduction daughter products such as vinyl chloride are found in the water.

One such plume originates at the Twin Cities Army Ammunition Plant near St. Paul, Minnesota. Microcosms were constructed with sediment from the source area of the plume. The rates of removal of cis-dichloroethylene, 1,1-dichloroethylene and vinyl chloride necessary to explain the existing distribution of contamination at field-scale range from 0.17 to 0.28 per year. Microcosms were constructed with material collected near the source area of the plume, using sediment from a reduced zone just below the water table, a reduced zone deeper into the aquifer, and a more oxidized zone even deeper into the aquifer. The rates of removal of cis-dichloroethylene varied from 0.43 to 2.3 per year. The rate of removal in microcosms that were sterilized by autoclaving the sediment were the same. There was no removal in container controls without sediment. The rate of removal of 1,1-dichloroethylene in the shallow reduced zone was 1.6 per year, and the rate of removal of vinyl chloride in the deepest more oxidized zone was 0.36 per year. Again, there was no difference between removal in “living” microcosms and sterile microcosms.

The plume of contamination at TCAAP has passed steady state and has started to recede.

The rates of abiotic transformation of the reduction daughter products in sediment from the contaminated aquifer are adequate to explain the behavior of the plume. Reduced iron minerals are common in aquifers that harbor chlorinated solvent plumes. Abiotic transformations may be more important than reductive dechlorination for natural attenuation of chlorinated solvents.

This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.